AD-A046 262 NAVAL UNDERWATER SYSTEMS CENTER NEWPORT R I F/G 13/7

A DEVICE FOR PRODUCTION TESTING THE TENSILE STRENGTH OF CERAMIC--ETC(U)

MAY 71 G M MAYER, H J CINI

UNCLASSIFIED NUSC-TM-EB11-29-71 NL

1 OF 1

AD A046262

END

DATE FILMED

12-77

DDC

NAVAL UNDERWATER SYSTEMS CENTER
NEWPORT, RHODE ISLAND 02840

Project No.
A-224-00-00

A DEVICE FOR PRODUCTION TESTING THE TENSILE STRENGTH OF CERAMIC RINGS

by

Gerald M. Mayer and Hector J. Cini

NUSC-TM-
Technical Memorandum No. EB11-29-71

10 May 1971

10 May 71

9p.

INTRODUCTION

The device described below was developed for better quality control of ceramic rings used in transducer construction. Previous tests conducted by Stanford Research Institute indicate that about 6% of the rings used in constructing TR-208 transducer elements have abnormally low tensile strength. This means that there is approximately 25% probability that a finished transducer element with a 4 ring stack will have at least one abnormally weak ring.

This production test device is used to stress each ring to a safe working level, approximately 60% of tensile yield strength and thereby eliminate any faulty rings before they are used in a transducer assembly.

DISCUSSION

The device is shown in Figure 1. A hydraulic pump supplies pressure to a small hydraulic jack, #1. Base plate #2, rubber washer #3, top plate #4 are held together by a bolt as an assembly and the bolt is threaded into the hydraulic jack #1. As the pressure is applied to the jack, the force causes the rubber washer #3 to compress against the base plate #4. This causes the rubber washer to expand radially and apply a uniform load on the ceramic ring. Releasing the pressure causes the rubber washer to return to its original position.

To test a ceramic ring, the ring is slipped over the top plate, down over the rubber washer, and brought to rest against the base plate. This positions the ring in line with the rubber washer. The assembly is then adjusted by the bolt so that the clearance between the ceramic ring and the rubber washer is approximately .002 to .005 inches.

Shroud #5 has a dual function. This is slipped over the assembly. The large hole fits over the ceramic ring under test and the shoulder of the small hole rests on the top surface of the ring. The small hole of the shroud fits over the top plate #4 and positions the shroud concentrically on the assembly. The shoulder on the shroud shorts out the electrical charge as the ring is stressed and protects the operator as he removed the ring which has passed the test. The large hole in the shroud fits over the ceramic ring and protects the operator from being injured by broken ceramic fragments from a ring that fractures.

Figure 2 shows an exploded view of the stress generating assembly and its component parts. Pressure gage #6 indicates the applied load in psi. No. 7 is a ceramic ring.

The stress impressed on the ceramic ring generated by the expanding rubber washer is determined by the load vs. stress calibration curve, Figure 3. This curve was generated by taking the average strain from two (2) strain gages on the outside diameter of a ceramic ring 90° apart and using a correction factor of 1.13 to obtain the maximum stress at the inner surface of the ring.

$$\text{Maximum stress} = 1.13 \times E \times e$$

The elastic modulus E was taken as 14×10^6 psi.

Figure 4 gives tabulated results on tensile tests on thirty-nine(39) TR-208A ceramic rings using the described device. Taking 10,000 psi as

the nominal tensile strength of the ceramic material and 60% of this as a safe working stress, it can be seen that three (3) rings are below the 6000 psi stress requirement. This indicates a 7.6% failure rate on the 39 rings. In a transducer of four (4) stacked rings using the above 39 rings, it is conceivable that one defective ring could have been used in three of the eight (8) transducer assemblies.

Ceramic rings of various diameters and heights can also be tested by merely changing the stress generating assembly parts #2, #3, and #4 to appropriate dimensions. The feature of the device is that it permits simulated hydrostatic loading without the use of a fluid medium.

Figure 5 is tabulated data on forty (40) ceramic rings tested to fracture. The data is self explanatory.

Figure 6 is tabulated in serial number order and stress at failure order. It is interesting to note in the stress at failure order that ring serial #'s 196, 194, 193, and 195 have the lowest stress at failure. The consecutive serial numbers suggest that this is not a randomly distributed weakness, but can probably be attributed to some event in the production process common to that group of rings.

RECOMMENDATIONS

It is recommended that a tensile strength test using a device similar to the one described above be made a specification requirement in the procurement of all ceramic rings intended for use in active sonar transducers.

Hector J. Cini	Gerald M. Mayer
HECTOR J. CINI	GERALD M. MAYER
Mechanical Engineering Technician	Supervisory Mechanical Engineer

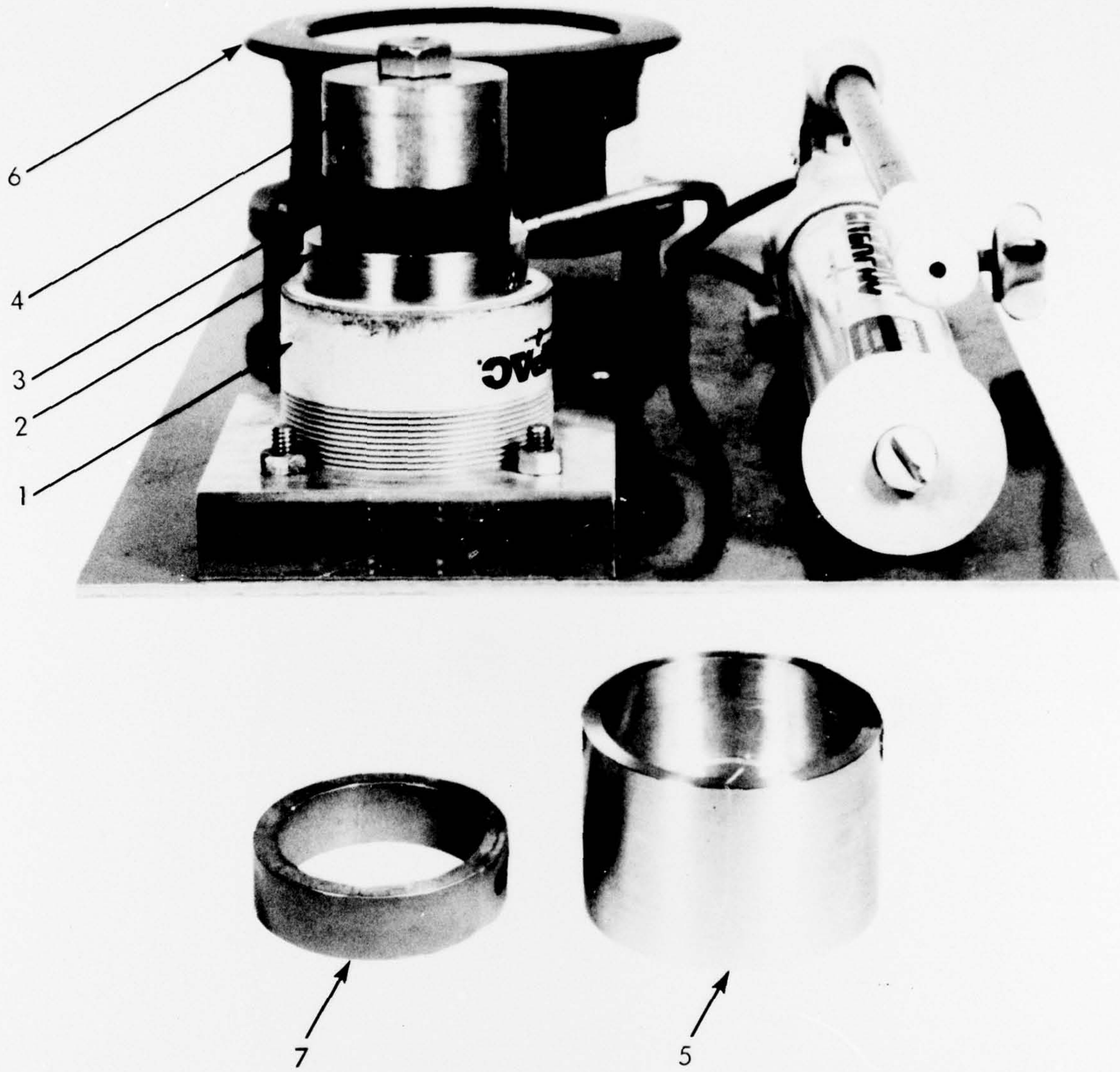

Fig. 1

NUSC Tech Memo No. EB11-29-71

Naval Underwater Systems Center
NP24 - 41111A - 5 - 71

Official Photograph

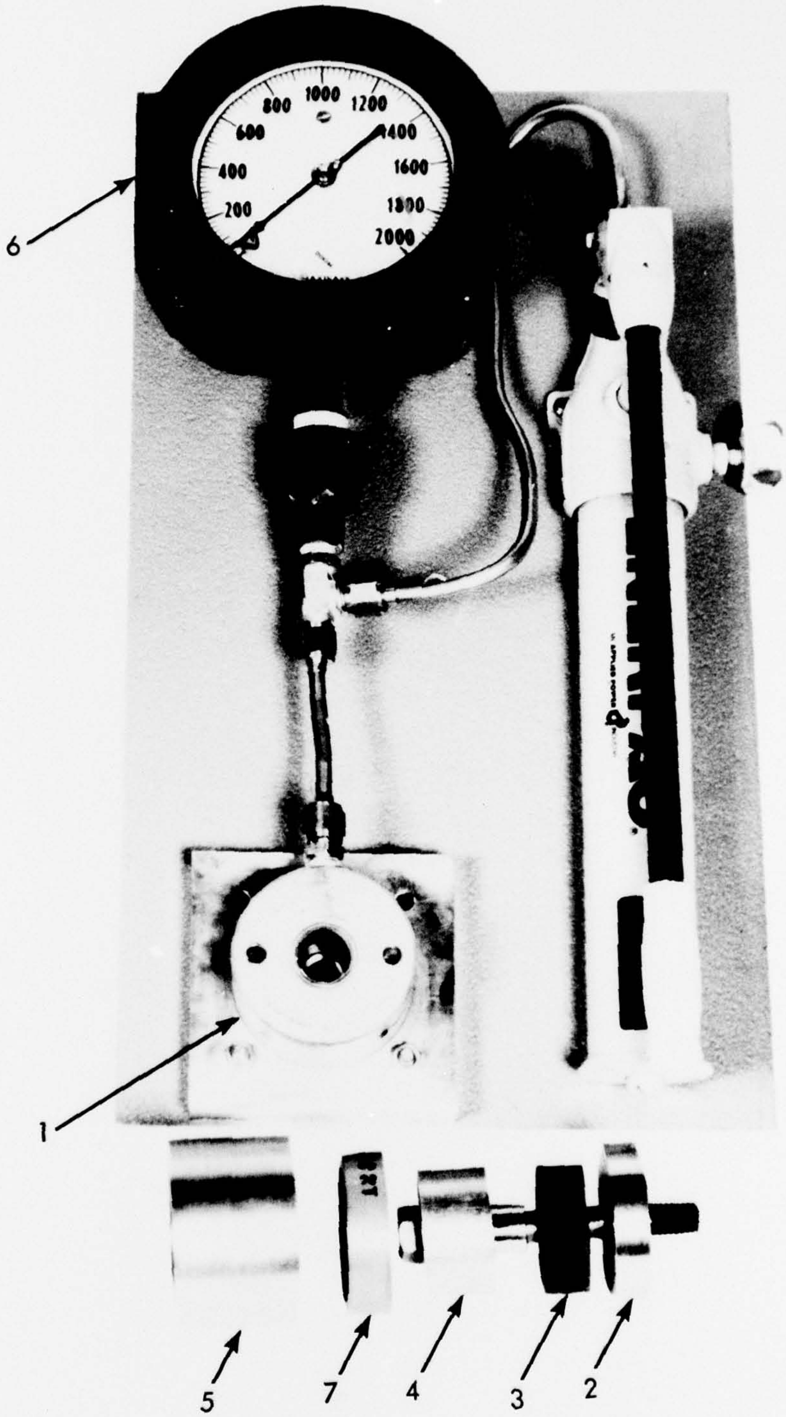

Fig. 2

NUSC Tech Memo No. EB11-29-71

Naval Underwater Systems Center
NP24 - 41110A - 5 - 71

Official Photograph

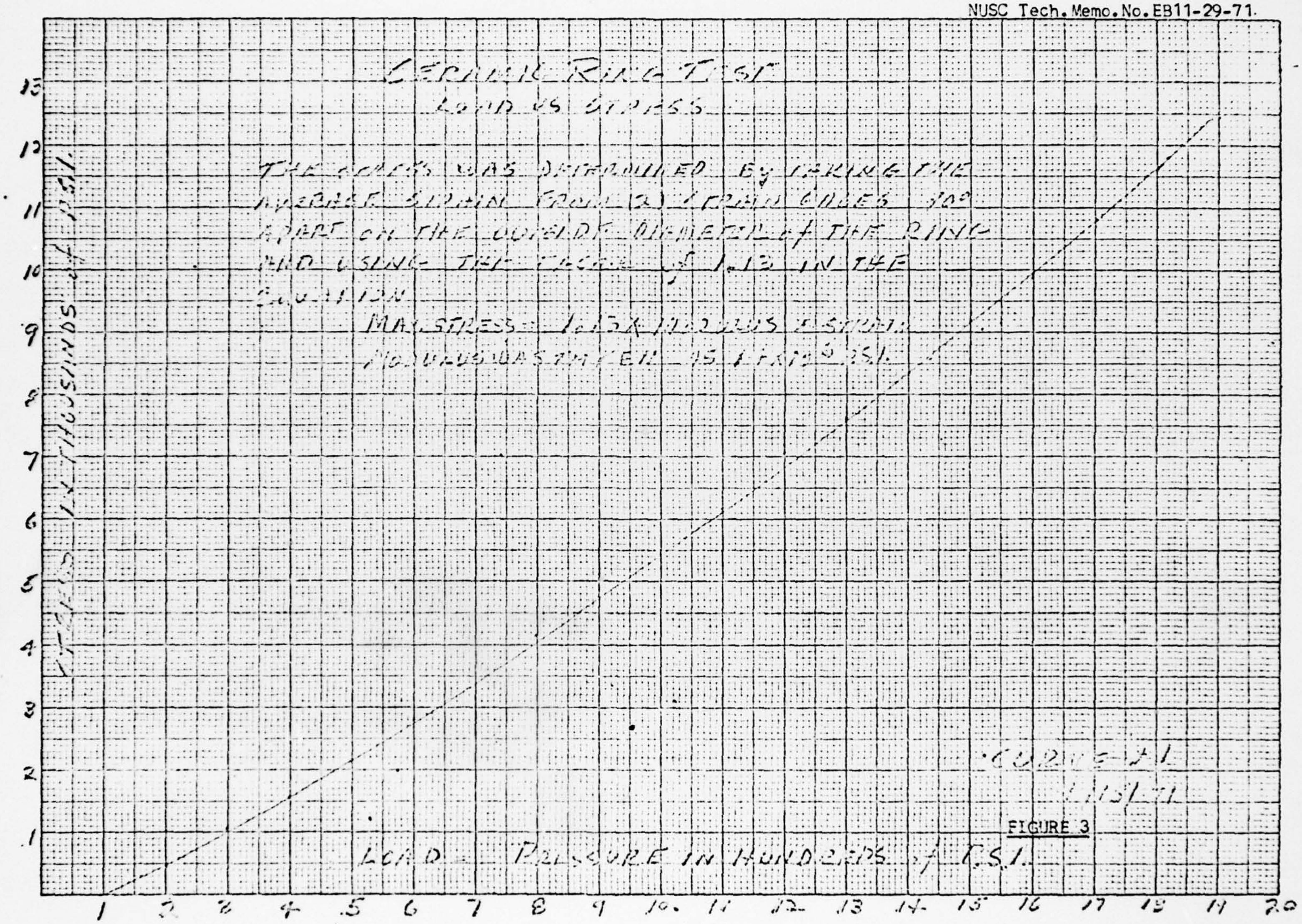

FIGURE 3

BEST AVAILABLE COPY

CERAMIC RING TEST

FIGURE 4

A total of thirty-nine (39) ceramic rings were tested using the described device. Each ring was taken to its ultimate tensile strength. The load at fracture was recorded and the stress determined from the calibration curve of Figure 1.

Ring Serial Number	Load PSI To Fracture	Stress PSI	Ring Serial Number	Load PSI To Fracture	Stress PSI
197	1740	11150	119	1740	11150
194	980	5300	105	1740	11150
193	1040	5700	98	1550	9600
200	1580	9800	113	1420	8500
195	1180	6700	86	1480	9000
199	1520	9300	87	1540	9500
196	500	2200	97	1740	11150
198	1280	7400	100	1720	11000
106	1440	8700	108	1640	10300
104	1680	10600	107	1780	11500
103	1440	8700	120	1400	8400
101	1760	11300	110	1240	7100
88	1850	12100	116	1660	10500
90	1480	9000	102	1680	10600
85	1800	11600	99	1640	10300
89	1800	11600	92	1800	11600
112	1380	8200	114	1420	8500
95	1700	10800	111	1580	9800
117	1620	10100	109	1760	11300
115	1640	10300	118	Accidently Broken	

CERAMIC RING TEST DATA
EDO WESTERN TR-208 RINGS

FIGURE 5 Tech. Memo. No. EB11-29-71

SERIAL #	LOAD AT FRACTURE	STRESS AT FRACTURE
197	1740	11,100
194	980	5,250
193	1040	5,700
200	1580	9,800
195	1180	6,660
199	1520	9,300
196	500	2,150
198	1280	7,420
106	1440	8,670
104	1680	10,610
103	1440	8,670
101	1760	11,300
88	1850	12,080
90	1480	9,000
85	1800	11,640
87	1800	11,640
112	1380	8,200
95	1700	10,760
117	1620	10,110
115	1640	10,290

TESTED TO DESTRUCTION AS RECEIVED

Mean fracture load 1470.5 (raw d.
Mean fracture stress 9017.5 psi (raw d.
σ_{load} — 330 (raw d.
σ_{stress} — 2481 psi (raw d.

SERIAL #	LOAD AT FRACTURE	STRESS AT FRACTURE
119	1740	11,100
105	1740	11,100
98	1550	9,550
113	1420	8,500
86	1480	9,000
87	1540	9,480
97	1740	11,100
100	1720	10,950
108	1640	10,290
107	1780	11,450
120	1400	8,350
110	1240	7,110
116	1660	10,460
102	1680	10,610
99	1640	10,290
92	1800	11,640
114	1420	8,500
111	1580	9,800
109	1760	11,300
118	NO DATA – BROKEN BY ACCIDENT	

TESTED TO DESTRUCTION AFTER HIGH FIELD MEASUREMENTS

Mean fracture load 1607 (raw d.
Mean fracture stress 10030 psi (raw d.
σ_{load} — 152 (raw d.
σ_{stress} — 1232 psi (raw d.

OVERALL FIGURES

$\left.\begin{array}{ll}\text{Mean fracture stress} - & 9511\ \text{psi} \\ \sigma_{stress} - & 2038\ \text{psi}\end{array}\right\}$ on raw data

$\left.\begin{array}{ll}\text{Mean fracture stress} - & 10201\ \text{psi} \\ \sigma_{stress} & 1116\ \text{psi}\end{array}\right\}$ After converging iterative process eliminating outside of mean $\pm 2\sigma$

BEST AVAILABLE COPY

CERAMIC RING TEST DATA

FIGURE 6

LISTED IN SER # ORDER

SER #	Stress at fracture
85	11640
86	9000
87	9480
88	12080
89	11640
90	9000
92	11640
95	10760
97	11100
98	9550
99	10290
100	10950
101	11300
102	10610
103	8670
104	10610
105	11100
106	8670
107	11450
108	10290
109	11300
110	7110
111	9800
112	8200
113	8500
114	8500
115	10290
116	10460
117	10110
118	NO DATA
119	11100
120	8350
193	5700
194	5250
195	6660
196	2150
197	11100
198	7420
199	9300
200	9800

LISTED IN FRACTURE STRESS [illegible]

Ser #	Stress at fracture	
196	2150	
194	5250	
193	5700	
195	6660	
110	7110	
198	7420	
112	8200	
120	8350	
114	8500	
113	8500	
103	8670	
106	8670	
86	9000	
90	9000	
199	9300	
87	9480	
98	9550	
111	9800	
200	9800	
117	10110	← MEDIAN
99	10290	
108	10290	
115	10290	
116	10460	
102	10610	
104	10610	
95	10760	
100	10950	
97	11100	
105	11100	
119	11100	
197	11100	
101	11300	
109	11300	
107	11450	
85	11640	
89	11640	
92	11640	
88	12080	
118	NO DATA	